

# **Accident Hazards on National Highways in Bangladesh**

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## **ABSTRACT**

Essentially "Safety Design and Engineering" has now emerged as the core function of contemporary road transport safety policies. Developing countries like Bangladesh however have been slower in devising and adopting such approach and many roads still remains substandard. There is widespread disregard of explicit safety considerations in the road planning, design and rehabilitation program. Black spots are still being created where many of the accidents and casualties could have been prevented by implementing simple road engineering and environmental measures based on proper safety checks or audits as well as road safety inspections encompassing systematic analysis of road infrastructure deficiencies. Each year nearly 5000 accidents as reported by the police occur in Bangladesh and around 40 percent of these accidents take place on national highways. Of the accidents and fatalities of known locations, the share of national highways is much higher, 56 percent and 61 percent respectively. About 43 percent of national highway accidents concentrated on 5 percent of the total length, demonstrating that accidents are highly clustered at few sections and they are amenable to targeted and site specific treatments. Extensive site investigations and analyses of data revealed that accident hazards associated with roads and roadsides were particularly prevalent.

The main purpose of this paper is to describe the prevalence of road environment hazards and deficiencies contributing to accidents on national highways in Bangladesh by citing examples of on-scene studies of selected high accident locations. The paper also highlights various corrective engineering measures relating to roadway geometric design and environmental improvements. It further comments on the urgency of introducing new approaches of road safety audit, inspection and risk assessment programs for rapid and sustained improvements of road safety at marginal cost.

## **1. INTRODUCTION**

The world experience is that significant reduction in road accidents and casualties can quickly and affordably be achieved by road infrastructure improvements essentially through application of targeted safety engineering countermeasures. Some national safety strategies in leading developed countries showed investment in safer infrastructure is expected to deliver twice the casualty savings provided by investment in either behaviour or vehicles (iRAP, 2008). Indeed, "Safety Design and Engineering" has now emerged as the core function of contemporary road transport safety policies. Developing countries like Bangladesh however have been slower in devising and adopting such approach and many roads still remains substandard. There is widespread disregard of explicit safety considerations in the road planning, design and rehabilitation program. Black spots are still being created where many of the accidents and casualties could have been prevented by implementing simple road engineering and environmental measures based on proper safety checks or audits as well as road safety inspections encompassing systematic analysis of road infrastructure deficiencies. The purpose of this paper is to provide an overview of road accident characteristics in Bangladesh and to describe the prevalence of widespread road environment hazards and deficiencies contributing to accidents on national highways in Bangladesh. The paper further highlights some potential

corrective measures and approaches for safety improvements in cognizance of some recent advances in road safety good practices.

## 2. THE ROAD TRANSPORT DEVELOPMENT IN BANGLADESH

Bangladesh is a country in South Asia and a member of SAARC. It is a very densely populated and a low lying country with about 150 million inhabitants living in an area of 147570 sq. km. i.e. around 1000 inhabitants live per sq. km. Being a riverine country, road transport plays an important role in catering for the increasing travel demand both for freight and passengers in Bangladesh. The number of registered motor vehicles on road increased steadily by about 210 percent in 17 years period, from 3,39,448 in 1990 to 10,54,057 in 2007. Nearly 75 percent of passengers and 65 percent of freight movement are taking place on the road system. In urban areas, non-motorized transport modes account for the largest share of all trips. Despite phenomenal growth in the number of motor vehicles the country's transport demand is still predominantly met by non-motorized modes particularly rickshaws and it's level of motorization is far below the levels in other Asian countries. Typical road traffic features and their operational and behavioural risk in rural and urban areas can be seen in Figures 1 (a to d). The present number of rickshaws in Bangladesh could be in the order of 8, 00,000. To cater for the growing demand of road transport the major road network (national highways, regional roads and feeder roads) increased from 15,670 km in 1994 to 22,378 km in 2001 (RHD website and BBS).

Although the rates of motor vehicle registration and road kilometrage have grown considerably they are still considered to be far short of the looming demand. These factors together with the large scale shift of traffic from other modes (viz. rail and water) to road, the process of rapid urbanization in conjunction with socio-economic parameters have resulted in enormous road traffic accident problems. Road accidents are increasing alarmingly taking heavy toll of human lives. Personal injuries and property damages are common daily phenomenon. The severity of accident outcomes is often devastating with a result of involving many fatalities and injuries. A large proportion of road fatalities occur on rural sections of the main highways.



(a)



(b)



(c)



(d)

Figure 1: Typical rural roads (a) & (b), urban roads (c) & (d)

## 3. STRIKING FEATURES OF ROAD ACCIDENT SITUATION IN BANGLADESH

A detailed analysis of police reported accident data during the period 1998-2007 revealed the following striking characteristics of accidents (see for details in Hoque et al. 2006a, 2006b).

- **Total Accidents and Fatalities:** There were at least 3749 fatalities and 3273 injuries in 4869 accidents as reported in 2007. Allowing for under reporting of accidents, the true total of fatalities could well be in the order of 12,000 each year. The number of fatalities has been increasing from 1495 in 1993 to 3749 in 2007, over 2.5 times in 14 years period. The statistics reveal that Bangladesh has one of the highest fatality rates in road accidents, over 100

deaths per 10,000 motor vehicles (excluding motorcycles). In economic terms, road accident in Bangladesh is costing the community in the order of nearly 2 percent of Gross Domestic Product (GDP).

- **Accident Locations and Severity:** About 75 percent of the fatalities and 65 percent of accidents occurred in rural areas. Accidents are predominantly occurred on road links both in urban and rural areas, 64 percent and 86 percent respectively. Rural accidents are more severe than the accidents in urban areas. About 2.5 percent of reported accidents occurred on bridges and culverts. The accidents were classified as fatal 65 percent, grievous injury 24 percent, simple injury 6 percent and collision type 5 percent. This clearly demonstrates the prevalence of significant under reporting of injury accidents.
- **Predominant Accident Types:** Hit-pedestrian is the most frequent type of accident which is nearly 44 percent of total accidents and 53 percent of all fatal accidents. This accident type is followed by rear end (16%), head on (13.6%) and overturning accidents (9.2%). These four accident type groups accounted for about 83 percent of all accidents and 86 percent of all fatal accidents.
- **Vehicles Involved in Accident:** Of the vehicles involved in all fatal accidents, nearly two-thirds are buses and trucks. This group of vehicles are particularly over involved in pedestrian fatalities. Involvement of car and other light vehicles in fatal accidents is 13 percent, followed by motorcycle and auto rickshaws, 7.5 percent. The shares of buses and trucks in registered vehicles are 13 percent.
- **Road Users Casualties:** Of those killed, nearly half are pedestrian. The children under 16 years of age accounted for about 21 percent of total fatalities. About one-third of the total pedestrian fatalities are children. Nearly 80 percent of the road deaths are in the age groups of 5 - 45 years which have significant economic and societal impacts.
- **Factors Contributing to Accident:** Understanding why accidents occur has been explored in-depth in studies worldwide. Many factors contribute to accident occurrence and most accidents involve more than one factor with the dominance of human factors followed by the road and vehicle factors. The principal contributing factors of accidents in Bangladesh are adverse roadway and roadside environment, poor detailed design of junctions and road sections, excessive speeding, overloading, dangerous overtaking, reckless driving, carelessness of road users, failure to obey mandatory traffic regulations, variety of vehicle characteristics and defects in vehicles and conflicting use of roads. Others include a low level of awareness of the safety problems, inadequate and unsatisfactory education, safety rules and regulations and traffic law enforcement and sanctions. It should be noted that although human errors contribute to the majority of the accidents, engineering and traffic management can aid and influence road users to change their behavior and can make their road environment safer through reducing conflicts. This is particularly relevant where road environmental deficiencies, excess and inappropriate speed, lack of perception and poor judgment and behavior are concern. Such situation is indeed most prevalent in Bangladesh.

#### 4. ACCIDENTS ON NATIONAL HIGHWAYS IN BANGLADESH

Detailed analysis and findings of accident investigation on national highways have been reported by Hoque (2006), and Hoque et.al. (2006). The distribution of total accidents according to road types is national highways 38 percent, 12 percent regional roads, 15 percent feeder roads, and others (including city streets) 35 percent. Figure 2 presents the comparative distribution of accidents, fatalities and road lengths by road types. Of the accidents and fatalities of known locations, the share of national highways is much higher, 56 percent and 61 percent respectively. It is clear that accidents on the national highways are of primary concern to improve the road safety situation in Bangladesh. More detailed analysis of accident distribution revealed that accidents are highly clustered on few sections of the national highways demonstrating that accidents are amenable to site specific treatments. This aspect has been examined in some greater detail to identify locations with high concentration of accidents and fatalities. The intensity of accidents (accidents per km) on national highway network was examined to identify the links of high concentration of accidents. This is shown in Figure 2. It can be seen that the national highway links in the central part connecting northern

regions are having high incidence of accidents. Of particular concern is the link N9 which represent the link with Jamuna Bridge and its approaches. On average nearly 100 accidents occurred on this link of nearly 38 km. Detailed studies of the accidents on this link are reported in Hoque et. al. (2008).

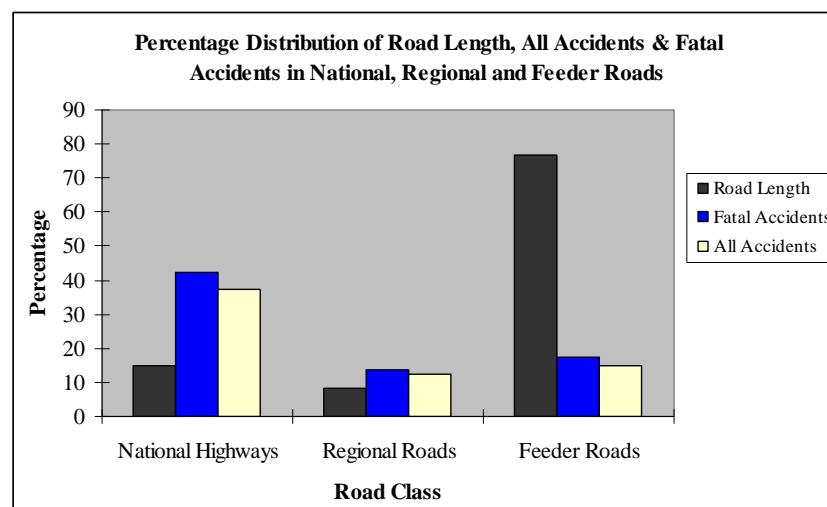


Figure 2: Percentage Distribution of Road length, Total accidents and Fatal Accidents in National, Regional and Feeder Roads

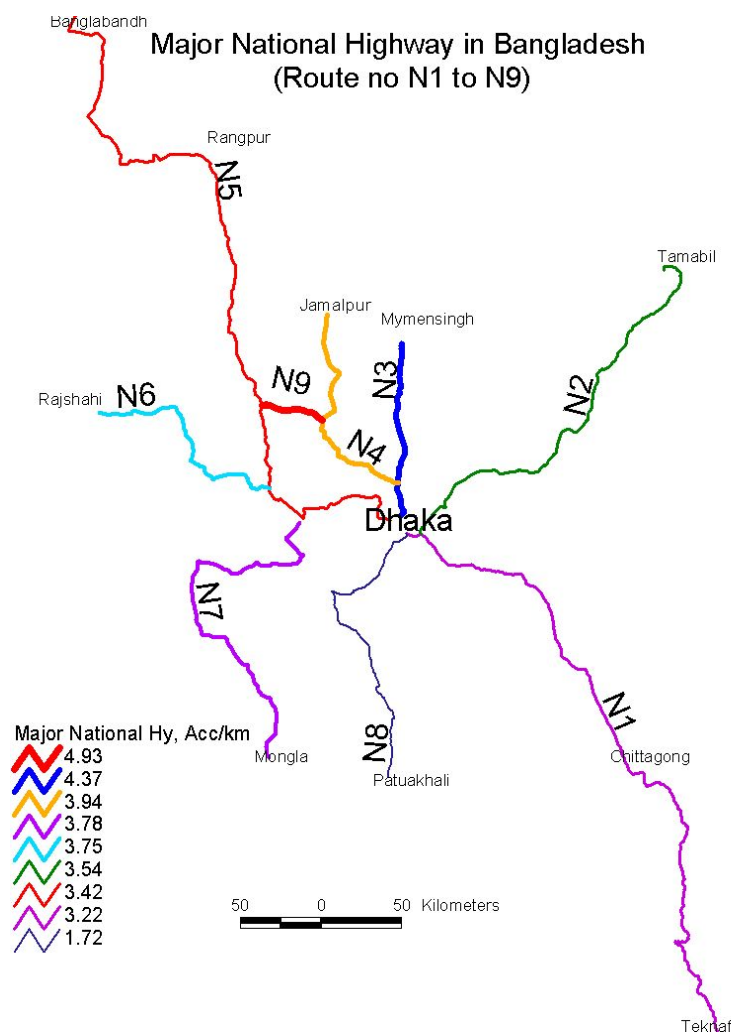


Figure 3: Major National Highways in Bangladesh Showing the Intensity of Accident Distribution (Accidents per Km.)

More frequent accident types on the national highways were also identified (see Hoque et. al. 2006c). Of the total reported accidents, hit pedestrian emerges as the most common type of accidents amounting to 40 percent of total accidents and 47 percent of all fatal accidents. This is followed by head on (18%), rear end (13%) and overturning (11%) types of accidents. These four accident type groups accounted for 82 percent of all accidents and 86 percent of all fatal accidents. The greater incidence of head-on types collision on national highways as compared with its share in total accidents, highly justifies the necessity of separating opposing traffic stream. The incidence of aggressive speeding was also evident on national highways. An examination of the distribution of accidents on a national highway corridor was made according to specified speed zones. It showed that higher incidence of accidents occurred on the designated highway segments of high-speed limit zones (Figure 4).

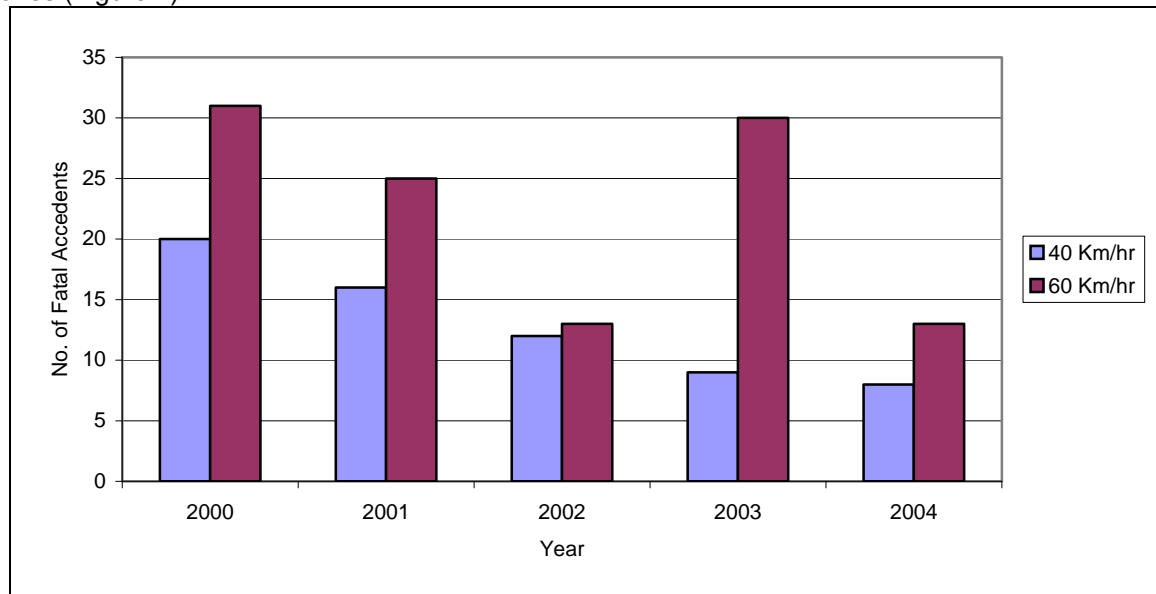


Figure 4. Distribution of Fatal Accidents on National Highway Corridor (Dhaka-Aricha Highway Section) with Varying Speed Limits (Newaz et al., 2006)

## 5. ACCIDENT HAZARDS ON NATIONAL HIGHWAYS: SOME CASE STUDIES

As discussed in the previous section, accidents are highly clustered at some specified locations and many major accidents are also frequently occurred at those locations. Studies revealed that about 45 percent of national highway accidents occurred in only 2 to 5 percent length of its total network resulting in a total of 280 to 350 locations identified as hazardous of having varying section lengths between 0.1 - 0.5 km each location.

Selected hazardous locations were studied by conducting on site visits and the specific road and road environmental hazardous are also identified. Studies in particular, gather roadway geometric and environmental conditions, nature and operational behavior of traffic, roadside development pattern, traffic management practices, abutting socio-economic and land use activities and discussion with the neighborhood people. Data from this site visits together with information from neighboring community were assembled for assessing the needed corrective measures.

Most striking features and roadway deficiencies common to all locations were briefly discussed with photographs showing the conflicts and deficiencies in Hoque et al (2006). Some of the case studies of such investigations are presented in the following sections.

### Case Study 1: On Scene Investigation of Bhoradoba Market

Bhoradoba market is located near Bhaluka on the Dhaka -Mymensingh Highway (N3). This market area is one of the most accident prone locations of the N-3 with a section length of 200 meter. There were 12 accidents having 17 fatalities with a total of 28 casualties in the period of 6 years. According to the local people the accident rate is very high with nearly 1 fatal accident per month. Pedestrians and Motorcyclists are the most vulnerable groups.



There are a number of shops, saw mills, hotels, tea stalls, rickshaw and tempo workshops, a police box and a katcha Bazaar which plies mainly on weekly market days (Sunday & Wednesday) around the area. On the market days large number of people gathered from adjacent areas and make the place highly crowded. More over there are a number of schools and spinning mill adjacent to the area which also generate considerable number of pedestrians.

The striking locational features and road environmental and traffic hazards are discussed.

#### **Road and Roadside Conditions:**

- This is a straight road section with two staggered access roads, one of which is linked with Ghatail Cantonment and Jamuna Bridge.
- Unmarked pavement condition is considered to be good. Smooth road surface and no potholes or undulations were found. However there is no usable shoulders or edge and centre line markings on the road.
- There is no dedicated side walk or cross walk facilities for pedestrians and absence of regulatory/warning signs or signals.
- Most of the temporary shops and stalls are built just besides the road which obstructs the visibility when traffic from access roads merges into the main traffic stream.
- Very complex and high roadside frictions with varied local activates and functions due to high concentration of retail/trading centers.
- Overall situation is worsen by illegally use of the roadsides for piling of wooden logs and other goods, parking and loading /unloading activities which force the pedestrians use the high-speed road carriage way.



Roadside temporary shops and damage roadsides



Stack of materials close proximity of roadsides



Tempos picking up passengers on roads are real danger for through traffic

#### **Traffic and Behavioural Characteristics**

- High speed, high occupancy through traffic mostly commercial vehicles very often have conflicts with local low speed operated minibuses, tempos and other non-standard vehicles, particularly NMVs from access roads. Traffic from unmarked access roads also creates hazards.
- The volume of motorcycle traffic is also high and most of the riders don't use safety helmet which makes them one of the prime vulnerable road user groups.
- Non-motorized vehicles like rickshaws, handcarts, and bicycles are also frequent on the highway and share the same carriageways in the absence of treated shoulders.



Uncontrolled poorly designed access road

### ***Pedestrian Activities and Facilities:***

- Within one square km area of Bhoradoba bazaar there is a high school, a primary school, a madrasa and a spinning mill. These institutions and shopping activities generate considerable amount of pedestrian traffic.
- Pedestrian activities and volume become critical on the *Hat* (market) days, often encroach paved roadways.
- There are no dedicated pedestrian sidewalk or crosswalk facilities and refuges.
- No barriers or pedestrian guardrails have been provided to regulate their movements and therefore exposes them to significant danger.

### ***Road Signs and Markings and Regulatory Devices***

- In general, road signs, markings and other regulatory devices were found to be very insignificant to regulate and control traffic. Even there was a regulatory sign which was obstructed by roadside trees resulted in restricted sight lines.
- Absence of edge line and centerline markings or other delineation devices lead drivers into unsafe operations and their path selection.
- The posted speed limit sign which was obstructed allows speed limit should be 20 km/hr. However observed average spot speeds found to be 55 km/hr for all vehicles and that of the high speed buses were around 75 km/hr- a significant safety hazards on this location.
- No effective self enforcing speed control or reducing measures could be found in the area.

### ***Potential Measures for Safety Improvements***

#### ***Traffic Related Measures:***

- The conflicting requirements of pedestrians, traders, worker and deliveries have to be separated by physical separation of the roadside stalls and retail activities off the road.
- As demonstrated, excessive speed and driver aggressiveness were one of the most commonly occurring contributory factors and therefore self enforcing physical measures are necessary to encourage and or force drivers to slow down.
- Compliance of speed limit signs and their strict enforcement.
- Some sort of speed calming devices (rumble strips or jiggle bars) may be placed to control over-speeding vehicles.
- Treatment and re-location of physical obstructions e.g. poles, trees, shops and other objects.
- Adequate access control through proper geometric design modifications of access roads and placement of give way and stop signs and markings.
- Designated pedestrian crossing facilities and refuges.
- Provision of rural bus bays to provide of road operation for bus to pickup/drop passengers
- Proper placement and maintenance of the regulatory and warning signs.

#### ***Behavioral Measures:***

- A local community based road safety program could be developed for raising safety awareness among the local people for their safety conscious behaviour and actions.
- Strict regulatory and law enforcement measures are seen important to reduce roadside frictions and hazards.

#### ***Roadway Geometric Measures:***

- Adequate shoulders and their proper maintenance of shoulders will help pedestrians to use for safe walking along the roadway as there is no dedicated roadway space for the pedestrians or the NMVs.
- Clearly defined central line and edges line are of critical importance for the safe and efficient operation of traffic and are vital in enabling drivers to look at and path selection on road ways.

### **Case Study 2: On Scene Investigation of Polashbari Bus Stand**

### **Description of the Site**

*Polashbari Bus Stand* is located on the National Highway - 5 (N-5) which is near Gaibandha district and some 270 km away from Dhaka. The location encompasses a section length of 1.7 kilometre (270.4 - 272.1 km). There were 19 accidents having 29 fatalities with a total of 32 casualties in the period of 6 years. Hit pedestrian is the most dominant type of accident (47 %), followed by 'side-swipe' (21 %), 'rear end' (15 %) and 'head on' (12 %). The peak hours of accidents are between 6.00 am and 9.00 am and 12.00 pm to 1.00 pm. Most accident victims are in the age group of 26-35 years. Buses are the most frequent vehicle type involved in accidents and fatalities accounting for about 40 percent of the total accidents. According to the local people, each day many collisions occur involving bicycle/rickshaws motorcycles and pedestrians resulting in simple/grievous injuries which are not usually reported.

Its an important growth centre. Many shops have been developed along both sides of the highway. Theses shops and several shop-related activities restricts pedestrians from using the shoulders along highway (see Figures 5). Furthermore, they create significant visibility problems when traffic from access roads merges into the main traffic stream. In addition to markets and shops, a cinema hall, a spinning mill and a fueling station are just beside this highway which are attracting significant number of traffic.



Figure 5: Free, unregulated and undisciplined on the highway.

### **Traffic Characteristics:**

- The composition of the vehicles plying on the highway shows that non-motorized vehicles (NMVs) are particularly predominant, 69 percent.
- Motorcycles accounted for nearly 15 percent of the total traffic volume. Most of the riders do not use safety helmets.
- The shares of buses, trucks, and car/jeep/tempo were 8 percent, 5 percent and 3 percent respectively.
- The conflicts between the high speed through traffic and local traffic particularly pedestrians and other NMVs are frequent. No regulatory measures were installed to control the speed of the vehicles passing through the section of the market area.
- Observed average spot speed for all motorized vehicles of 51 km/hr was found and for the buses the mean speed was around 69 km/hr which is considered to be quite high for such a busy high intensity built-up area of local activity.
- Since this location is the central place all economic, social and cultural activities of about seven adjoining villages, massive pedestrian activities are observed and the volume of pedestrians becomes highest during the *Hat* days. The pedestrian movement is dispersed, numerous and unregulated. There are no dedicated pedestrian sidewalk or crosswalk facilities and due to encroachment of shoulders, pedestrians are forced to use the carriageway.

### **Observed Environmental Hazards:**

Significant road environmental and traffic operation hazards were observed almost similar to that outlined in case study one. These include: uncontrolled road side land use development; road space occupation by road traders and commercial activities; high intensity NMV traffic in the absence of NMV facilities; vehicle loading/unloading, parking and damaged/broken vehicles on roadways;



absence of designated off carriageway bus stops, pedestrian facilities; road shoulder defects; road side objects; obstruction and vegetations, absence of road markings and other delineation devices and frequent uncontrolled abutting access and local side road accesses. The glimpses of such hazards are shown in Figures 6.



Figure 6: Hazards of truck loading and standing, roadside objects



Figure 7: Roadside encroachment and high pedestrian movement reduce the effective carriageway width creating enormous safety hazards

### ***Potential Measures for Safety Improvements***

The problem characteristics of this site dictated similar physical and behavioural road safety countermeasures outlined for the previous site could be applied. An important safety measure demands priority at this site is the separation of shopping areas and road side stalls from the main road by service/frontage roads along roadsides to provide safe operation of the local settlement.

## **6. DISCUSSIONS AND CONCLUSIONS**

Road traffic accidents result from failures in the interaction of humans, vehicles and the road environment - the elements which produce the road traffic system. The combination of these various elements to produce road accidents means that road safety itself has to be tackled in a multi-functional manner in order to break the chains of events that lead to accidents and the eventual injuries of road users and property damages. There is now a growing assertion that the road environment is a most important determinant of accident frequency. Indeed it is the road and road component which the traffic engineer and the planner can most directly affect.

On-scene in-depth study of accident locations revealed that factors relating to road environment are significant in road accidents in Bangladesh and the road design features are indeed

associated with particular accident types and hazards. This paper has highlighted striking road accident characteristics and outlined typical road and road environmental safety hazards identified through selected case studies on national highways which accounted for nearly 40 percent of reported fatalities. The problem characteristics dictate priorities to be placed on corrective measures relating to road design and environmental improvements to eliminate the hazards, obstacles and bottlenecks as well to channel orderly behaviour of road users. Large reductions in accidents are potentially possible and indeed urgently needed include treatments and provision of roadway shoulders, self enforcing speed reducing measures, special facilities for pedestrians and other NMV traffic, treatment of roadside hazards, special off-road bus stops facilities, installation of delineation devices and others. Given that pedestrian accidents and conflicts are the biggest problem in terms of vulnerability, it is very urgent to provide physically separated spaces in the form segregated footways. A fairly common characteristic is that the local mismanagement of urban development, roadside activities and land use is most crucial as they often produce more traffic and conflicts than necessary. Unregulated private access to such interurban highways leads to endless linear settlements with high risks. Reductions and control of such conflict points has the enormous potential to reduce particular accident types and thereby aid significant safety. Importantly, the principles of forgiving roadway design and clear recovery area should always and strictly be incorporated. Detailed discussions on the aspect of comprehensive corrective measures are committed and will be dealt with those separately.

The findings highlighted the very real need for increased awareness of road safety in the design and management of the road infrastructures. It is time and very urgent to ensure that the road and its environment are put into safety through both reactive (identification and treatment of hazardous locations) and proactive approaches (introduction of road safety audit, inspection and assessment programs). Importantly, application of such approaches needs clear understanding of and constant reference to fundamental safety principles and operational elements of safer road designs viz. to provide guidance, information, warn, control and forgive the drivers and there should not be no surprises to the drivers and should avoid discontinuities in the roadway environment. The systematic accident investigation in this regard can lead to the implementation of most cost-effective countermeasures aimed at specific accident types and/or specific road user groups.

Corrections and fixing of existing road safety hazards demonstrated in the paper are indeed an enormous challenge to road engineering professionals in Bangladesh. Shortage of safety expertise, research and requisite funding are now significant constraints. It is therefore a priority for Bangladesh to address such safety issues with significant institutional improvements through sharing knowledge and experience of effective road safety programs worldwide. Much more research and studies require for enhancing our understanding of relationships between road design features and accident characteristics.

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